

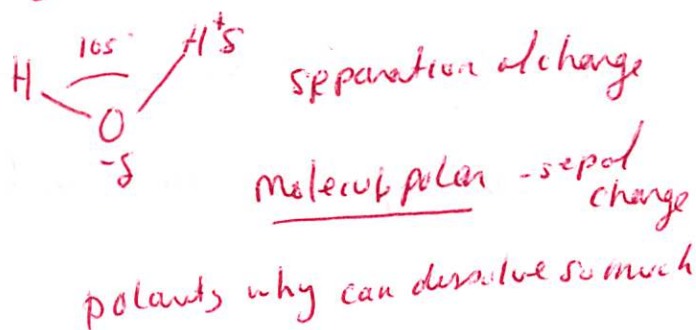
## Ch 4 Types of Rxns + Soln Stoch

All solutions are aqueous that we use

~~Q~~ Soln Chem important for all analysis, Blood Tests, water pollution

### 4.1 Water the common solvent

Substances dissolve  $\rightarrow$   $H_2O$ 's geometry



Dissolve ionic comp via hydration - salt dissolves b/c of attraction

Fig 4.2 allows individual ions to be free floating



amount of solubility depends on comp. some ions attraction

for each other much greater than  $H_2O$  ion attraction. so

not every thing dissolves — Ch 11

Non ionic subs also dissolve id like EtOH

Fig 4.3 show like dissolve like

## 4.2 Nature of aqueous solutions

Strong / weak electrolytes

Terms to know Solute Solvent

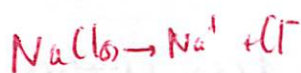
Electrolytes - strong / weak / non (depends on H<sub>2</sub>O / 100%)

First ID'd By Svante Arrhenius (1859-1927) - conductivity B/c ions  
later proven true w/ discovery of

### Strong Electrolytes

↳ ionic salts, strong acids, strong Bases

all ionize completely

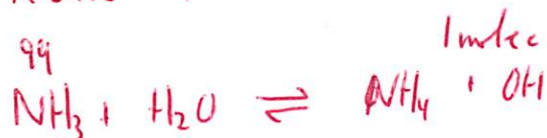
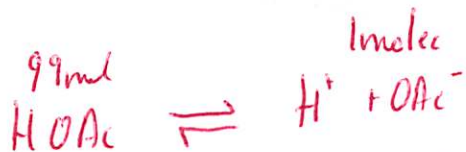


(what are strong acids)

only 1 H<sub>2</sub>SO<sub>4</sub> comes off

## Weak electrolytes

Weak acids } partial  
Weak bases } ionized



Nonelectrolytes  $\rightarrow$  No ionization



4.3 Comp of Solns  $\rightarrow$  w/ chem rxns in soln we must know

① Nature of Rxn

② amounts of chemicals needed & Released [ ]

only 1 [ ] from Now Molarity

$$\text{Molarity} = M = \frac{\text{mol solute}}{\text{L soln}}$$

Review simple Molar calc from  $\frac{\text{mass}}{\text{volume etc.}}$   
also [ ] of ions



Standard Soln - soln of accurately known [ ]

1.00 L of 0.200 M  $K_2Cr_2O_7$  How much  $K_2Cr_2O_7$  must be used?

How do you make the soln? Volumetric

Dilutions mol solute after dilution = moles solute b4 dilute

$$M_1 V_1 = M_2 V_2$$

What volume of 17.4 M  $HNO_3$  needed to determine 500 mL of 1.00 M?

#### 4.4 Types of Rxns

3 Types  
ppt Rxns  
Acid Base Rxns  
Redox Rxns

4.5 ppt Rxns - Rxn driven when a solid forms  
 $K_2CrO_4(aq) + Ba(NO_3)_2(aq) \rightarrow Ba\overset{(ppt)}{CrO_4}(s) + 2KNO_3(aq)$

predict what solid is by knowing color of ions  
 $Cu^{2+}$ ,  $Cu^+$ ,  $CrO_4^{2-}$  etc

know solubility Rules table 4.1

predict  $KNO_3 + BaCl_2$

$Na_2SO_4 + Pb(NO_3)_2$

$KOH + Fe(NO_3)_3$

# Solubilities

## Solubility rules

All nitrates, acetates and chlorates are soluble.

All chlorides are soluble except  $\text{AgCl}$ ,  $\text{PbCl}_2$ ,  $\text{Hg}_2\text{Cl}_2$   $\text{Br}^-$ ,  $\text{I}^-$

Most sulfates are soluble except  $\text{SrSO}_4$ ,  $\text{BaSO}_4$ , and  $\text{PbSO}_4$

All carbonates are insoluble except Group I and  $\text{NH}_4^+$

All hydroxides are insoluble except Group I,  $\text{Sr}(\text{OH})_2$ ,  $\text{Ba}(\text{OH})_2$

All sulfides are insoluble except Group I, Group II,  $\text{NH}_4^+$ .

## Dissolving rule

Insoluble salts of weak acid anions will often dissolve in strong acids

# Oxidation-Reduction Reactions

## Common Oxidizing Agents;

$\text{MnO}_4^-$  in acidic solution

$\text{MnO}_4^-$  in neutral or basic solution

$\text{Cr}_2\text{O}_7^{2-}$  in acidic solution

$\text{HNO}_3$ , concentrated

$\text{HNO}_3$ , dilute

$\text{H}_2\text{SO}_4$ , concentrated

Metal-ic ions

Halogens

$\text{H}_2\text{O}_2$

## Species formed;

$\text{Mn}^{2+}$

$\text{MnO}_2$

$\text{Cr}^{3+}$

$\text{NO}_2$

$\text{NO}$

$\text{SO}_2$

Metal-ous ions

Halides

$\text{H}_2\text{O}$

## Important Reducing Agents;

Halide ions ( $\text{X}^-$ )

$\text{X}_2$ , dilute basic solution

$\text{X}_2$ , conc. basic solution

Metals

$\text{SO}_3^{2-}$  (or  $\text{SO}_2$ )

$\text{NO}_2^-$

## Species formed;

$\text{X}_2$

$\text{XO}^-$

$\text{XO}_3^-$

Metal ions

$\text{SO}_4^{2-}$

$\text{NO}_3^-$

## Acid-Base Behavior

*In the hand students  
NEED TO KNOW AP*

### Strong Acids;

HCl, HBr, HI, HNO<sub>3</sub>, H<sub>2</sub>SO<sub>4</sub>, HClO<sub>4</sub> (All others are weak.)

### Reactions with

- a. active metals; H<sub>2</sub> formed
- b. oxides and hydroxides; H<sub>2</sub>O and salt formed
- c. salts to form gases or weak acids
  - carbonates; CO<sub>2</sub> and H<sub>2</sub>O
  - sulfites; SO<sub>2</sub> and H<sub>2</sub>O
  - sulfides; H<sub>2</sub>S
  - hydrides; H<sub>2</sub>
  - acetates; HC<sub>2</sub>H<sub>3</sub>O<sub>2</sub>, nitrites; HNO<sub>2</sub>

### Strong Bases;

NaOH, KOH, Ca(OH)<sub>2</sub>, Ba(OH)<sub>2</sub> (All others are weak)

### Reactions with

- a. acids; H<sub>2</sub>O and salt formed
- b. most metal ions; M(OH)<sub>x</sub> formed
- c. Al<sup>3+</sup>; Al(OH)<sub>4</sub><sup>-</sup>
- d. Al; H<sub>2</sub> and Al(OH)<sub>4</sub><sup>-</sup>
- e. NH<sub>4</sub>X; NH<sub>3</sub> formed

### Hydrolysis

- a. metallic oxides; OH<sup>-</sup> formed
- b. nonmetallic oxides; acid formed
- c. hydrides; H<sub>2</sub> and OH<sup>-</sup> formed

### Lewis acid-base reactions

- a. NH<sub>3</sub> + metal ions or compounds
- b. NH<sub>3</sub> + BX<sub>3</sub>
- c. NH<sub>4</sub>SCN + Fe<sup>3+</sup>

*# of ligand is 2x the valence of ion*  

$$\text{NH}_3 + \text{Ni}^{2+} \rightarrow \text{Ni}(\text{NH}_3)_4^{+2}?$$

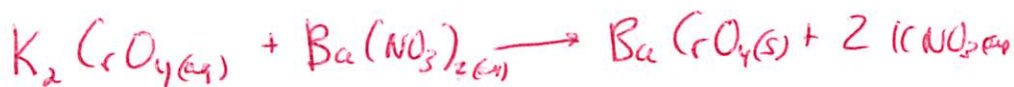


## 4.6 Ionic Eqns

(3)

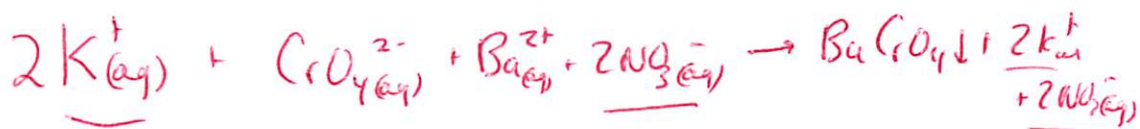
### Formula Eqn

Shows Reactant +  
Product Comps



### Complete Ionic Eqn

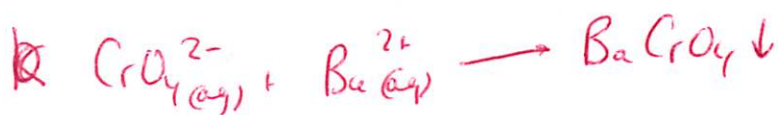
Shows all strong  
Electrolytes as  
Ions



Spectator ions - ions not participating  
in Rxn

### Net Ionic Eqn

only ions  
directly in Rxn  
are involved



Can do Stoch w/ ppt Rxns

① Calculate mass of NaCl that must be added to 1.50L of  
0.1M  $AgNO_3$  to <sup>completely</sup> ppt the  $Ag^+$  ions

2 Calculate mass of ppt formed when 1.25L of 0.0500M  $Pb(NO_3)_2$  + 2.00L of 0.0250M  
 $Na_2SO_4$  are mixed?

## 4.8 Acid - Base Rxns

Brønsted-Lowry - donor / acceptor

How do you tell if the Rxn took place

### Neutralization

28.0 mL of 0.250 M  $\text{HNO}_3$  + 53.0 mL of 0.320 M  $\text{KOH}$   
Calculate the amount of  $\text{H}_2\text{O}$  formed + what's the resulting  $[\text{H}^+] + [\text{OH}^-]$ ?

### Acid Base Titrations

↳ delivery of a measured volume of a soln of known  $[\ ]$  (titrant) into a soln containing the sub being analyzed (analyte)

Equivalence Point - point @ which titrant + ~~analyte~~ <sup>added to React</sup> exactly w/ analyte

Indicator changes color @ or near Equiv point

End point is where indicator changes color.

Do problem 4.14 pg 153

4.15



## Oxidation Reduction Rxns



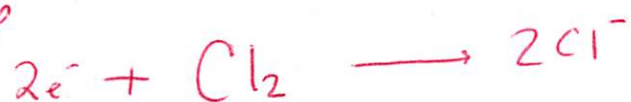
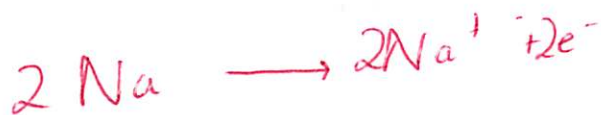
↳ Rxns where  $e^-$  are transferred



decomp

Comb

S. Rep



Photosynth

Fat, Sugar, Protein

Metabolism and Redox

Combustion

To understand we need to look @ oxidation states

Oxidation states (H's) - way to keep track of  $e^-$

Not arbitrary

Covalent Bond  $\rightarrow e^-$  are split equally for non polar bond  
 $e^-$  are assigned to more  $e^-$  negative

Rules - atom of uncombined element = 0 Na, O<sub>2</sub>, O<sub>3</sub> etc  
 monatomic ion same as charge  $\text{Na}^+ = +1$

F is always -1

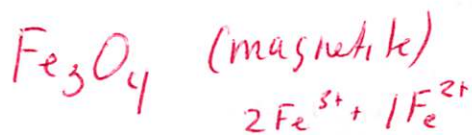
Oxygen -2 unless

Peroxide  $\text{O}_2^{2-} = -1$

H is +1 in compounds

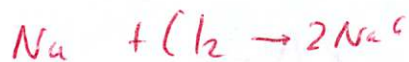
all equal 0 or charge of ion.

assign to  $\text{CO}_2 + \text{SF}_6 + \text{NO}_3^-$



ok way system  
 says

Go over ox & Red



Oxidation - loss of  $e^-$

Oxidizing agent -  $e^-$  acceptor (gets reduced)

Reduction gain of  $e^-$

Reducing agent  $e^-$  donor (gets oxidized)

Sample 4.18

Balancing Redox. S. Rep, Syn are easy Some not  
Comb

aqueous <sup>Redox</sup> are hard to Balance

2 ways to do it. acidic condition

Basic condition

Work

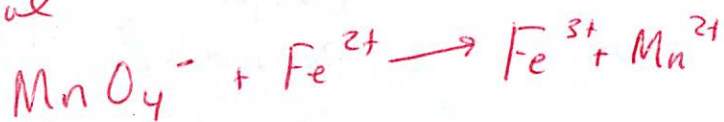
Use half Rxn Method

↳ separate ox + Red in 2 steps

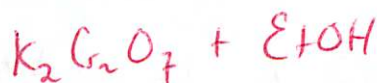
acidic

1. Write separate  $1/2$  Rxns
2. a Balance all elements but  $H_2O$   
b Balance O using  $H_2O$   
c Balance H using  $H^+$   
d Bal charge w/  $e^-$
3. Bal  $1/2$  Rxns by mult by integer +
4. Add  $1/2$  Rxns + Check Math

Bal



Ex 4.19



## Balancing via Basic Conditions

- Use  $\frac{1}{2}$  Rxn method as acidic.

- When get to final Eqn add  $\text{OH}^-$  ions to both sides to <sup>equal</sup> ~~cancel out~~  $\text{H}^+$

Then Form  $\text{H}_2\text{O}$  from  $\text{H}^+ + \text{OH}^-$  and cancel ~~cancel~~ common  $\text{H}_2\text{O}$  molecules on both sides

